THE PERIODICAL LITERATURE OF BIOCHEMISTRY*

By Herman H. Henkle, *Director*
School of Library Science, Simmons College, Boston

The evaluation of printed materials is a matter of primary importance to librarians, and any aid in this direction is welcomed by them. This is especially true in respect to the periodical literature in the sciences. Attempts have been made with moderate success to apply objective methods of evaluation. In 1927, Gross and Gross[6] set a pattern for the evaluation of chemical periodicals which has since been followed for physics and radio,[9] mathematics,[1] geology,[7] electrical engineering,[3, 14] civil engineering,[13] child guidance,[12] the medical sciences,[4, 11, 16] dentistry,[8] endocrinology,[5] and endocrinology of sex.[15]

Assuming that the composite of all bibliographical citations accompanying published scientific papers represents the group judgment of scientists as to which publications are most significant, statistical analyses have been made of such citations to scientific journals, to determine those journals most important to research workers, and most deserving of purchase by libraries. Lists of journals are tabulated in the order of the frequency with which they are cited, this frequency being accepted as representing the relative importance of the journals. The validity of the assumption upon which this procedure is based is dependent upon whether the source from which the citations are tabulated is representative of the subject field for which the leading journals are being determined, and whether a sufficiently large sample is taken to assure reliability. Unfortunately very little attention has been paid to the latter in many of the studies.

The papers by Gregory,[4, 5] Hackh,[8] Jenkins,[11, 12] Mengert,[15] and Sherwood[16] represent applications of the method described to periodicals of bio-medical interest. Through these, and other interesting papers such as those by Cunningham[2] and Hunt[10] the medical librarian may acquire much useful information. For the reason that periodicals of general medicine have been so fully treated, repetition is avoided here by reporting the results of a study in which the methods of statistical bibliography were applied to an evaluation of the periodical literature of biochemistry.

When the first volume of the *Annual Review of Biochemistry* appeared in 1932, it seemed to present a good source for information about

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the distribution of biochemical literature. This was borne out in the analysis of the bibliographies. The danger of bias favoring periodicals in certain languages, or favoring some schools of thought was obviated by the fact that there was some change of reviewers each year, and that during the five-year period covered by the analysis more than fifteen countries were represented.

The bibliographies were analyzed statistically and a list of journals arranged in the order of the frequency with which they were cited. This process was repeated each year for each new volume through volume 5 (1936). This was done to check the reliability of a single volume of the *Annual Review* for showing the relative importance of scientific journals for biochemistry. The percentage scores of the leading journals as indicated by each of the five volumes of the *Annual Review* were correlated with the scores of the leading journals as indicated by each of the other volumes and within various combinations. Results ranging from $.864 \pm .003$ to $.998 \pm .001$ indicated that any volume or combination of volumes represented a reliable sample of the literature.

In determining sample reliability, the percentage scores of the leading journals only were used. As a check against this method, correlation coefficients were calculated for different proportions of the distribution from twenty through seventy-eight of the most frequently cited titles, beyond which each additional periodical contributed less than 0.2 of one per cent. of the total number of citations. The uniformity of the several coefficients given in Table 1 indicates that no important error is introduced by the elimination of the "tail" of the distribution (see Figure 1) in the determination of sample reliability.

TABLE 1

Coefficients of correlation for different proportions of the distribution of journal titles as tabulated from the *Annual Review of Biochemistry*, vol. I and II (1932 and 1933)

Scores	1.0% or more N=20	0.8% or more N=25	0.5% or more N=33	0.3% or more N=53	0.2% or more N=78
r=	$.974 \pm .002$	$.974 \pm .001$	$.972 \pm 001.$	$.973 \pm .001$	$.969 \pm .001$

Jenkins,[11] Mengert,[15] and Gregory[4] have reported how the distribution of significant literature in various scientific journals illustrates the law of diminishing returns. The same holds true with the literature of biochemistry. Of special interest from the standpoint of theoretical considerations in statistical bibliography is the high degree of uniformity of this phenomenon in different samples of the literature. This is illustrated in Figure 1, where three cumulative frequency curves of the percentage of citations in periodicals titles are superimposed. For further theoretical considerations the reader is referred to Dalziel.[3]

The five volumes of the *Annual Review of Biochemistry* contain

17,198 references to 851 periodicals. The first four titles contain 32 per cent of the significant literature, and thirty-seven titles contain approximately 70 per cent. The principal portion of the literature is fairly well

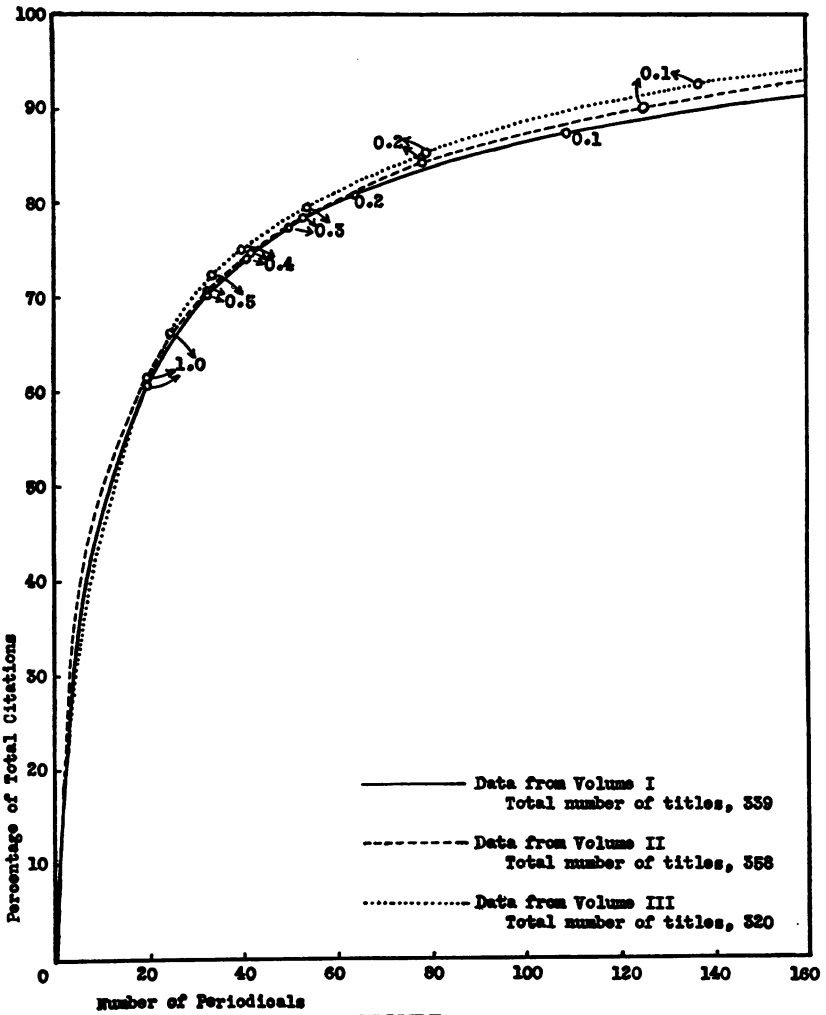

FIGURE 1

Cumulative frequency curves showing the degrees of concentration and dispersion of the periodical literature of biochemistry. Data compiled from the *Annual Review of Biochemistry,* vol. I-III (1932-1934). The points on the curves indicate the percentage of literature in each periodical at that position.

concentrated into relatively few journals, but the total current literature is remarkably dispersed. The journals which include 0.4 of one per cent or more of the literature are given in Table 2 in the order of their relative importance for biochemistry.

TABLE 2

Leading periodicals for Biochemistry as indicated by analysis of the bibliographical citations in the *Annual Review of Biochemistry*, vol. I–V (1932–1936)

Rank	Name of Journal	Number of Citations	Cumulative % of Total
1	*Journal of Biological Chemistry*	1,614	9.384
2	*Biochemische Zeitschrift*	1,381	17.414
3	*Biochemical Journal*	1,255	24.711
4	*Hoppe-Seyler's Zeitschrift für physiologische Chemie*	1,219	31.799
5	*American Journal of Physiology*	603	35.305
6	*Society for Experimental Biology and Medicine. Proceedings*	478	38.084
7	*Deutsche chemische Gesellschaft. Bericht*	462	40.770
8	*Société de Biologie. Comptes Rendus*	409	43.148
9	*American Chemical Society. Journal*	325	45.037
10	*Journal of Physiology*	321	46.903
11	*Klinische Wochenschrift*	270	48.472
12	*Nature*	254	49.949
13	*Helvetica Chemica Acta*	242	51.356
14	*Journal of Nutrition*	236	52.728
15	*Chemical Society, London. Journal*	222	54.018
16	*Académie des Sciences, Paris. Comptes Rendus*	183	55.082
17	*Journal of General Physiology*	181	56.034
18	*Société de Chimie Biologique, Paris. Bulletin*	176	57.057
19	*Archiv für experimentelle Pathologie und Pharmakologie*	174	58.068
20	*Justus Liebig's Annalen der Chemie*	171	59.062
21	*Pflüger's Archiv für die gesamte Physiologie*	170	60.050
22	*Die Naturwissenschaften*	168	61.027
23	*Science*	154	61.922
24	*Royal Society of London. Proceedings, Series B*	145	62.765
25	*Journal of Experimental Medicine*	136	63.556
26	*Journal of Clinical Investigation*	126	64.289
27	*Zeitschrift für die gesamte experimentelle Medizin*	121	64.993
28	*Lancet*	117	65.673
29	*Archives of Internal Medicine*	99	66.249
30	*American Medical Association. Journal*	95	66.801
31	*British Journal of Experimental Pathology*	79	67.260
32	*Journal of Biochemistry, Tokyo*	79	67.719
33	*Società Italiana di Biologie Sperimentale. Bollettino*	78	68.173
34	*Zeitschrift für Immunitätsforschung und experimentelle Therapie*	78	68.627
35	*Journal of Pharmacology and Experimental Therapeutics*	75	69.063
36	*Endocrinology*	70	69.470
37	*Society of Chemical Industry, London. Journal*	69	69.871
	814 other titles	5,163	99.916
	Total number of citations	17,198	

The literature of forty-five different subjects was reviewed in the five-year period. For the most part these subjects were not reviewed frequently enough, or were not represented by sufficient citations to indicate reliably the most important journals. Some, however, were reviewed in each of the annual volumes, and are represented by a considerable literature. Seven of these subjects with the journals containing 2 per cent or more of the literature for the respective subjects are presented in Table 3.

Caution is advisable in the use of these lists. It has been shown by

TABLE 3

Leading periodicals for each of seven aspects of biochemistry as indicated by analysis of the bibliographical citations in the *Annual Review of Biochemistry*, vol. I–V (1932–1936)

Subject	Total Number of Periodicals	Total Number of References	Leading Journals	Number of References	Cumulative % of References
Chemistry of proteins and amino acids	84	850	*Journal of Biological Chemistry*	191	22.5
			Biochemische Zeitschrift	75	31.3
			Biochemical Journal	73	39.9
			American Chemical Society. Journal	71	48.2
			Hoppe-Seyler's Zeitschrift für physiologische Chemie	60	55.3
			Journal of General Physiology	52	61.4
			Faraday Society, London. Proceedings	25	64.3
			Deutsche chemische Gesellschaft. Bericht	23	67.0
			Carlsberg Laboratoriet, Copenhagen. Comptes Rendus	17	69.0
Metabolism of proteins and amino acids	92	735	*Hoppe-Seyler's Zeitschrift für physiologische Chemie*	129	17.5
			Journal of Biological Chemistry	120	33.9
			Biochemische Zeitschrift	117	49.8
			Biochemical Journal	50	56.6
			Archives of Internal Medicine	27	60.3
			Klinische Wochenschrift	24	63.5
			Archiv für experimentelle Pathologie und Pharmakologie	22	66.5
			Archives of Internal Medicine	20	69.2
Chemistry of carbohydrates and the glycosides	65	565	*Deutsche chemische Gesellschaft. Bericht*	144	25.5
			Chemical Society, London. Journal	78	39.3
			American Chemical Society. Journal	74	52.4
			Journal of Biological Chemistry	47	60.7
			Justus Liebig's Annalen der Chemie	28	65.7
			Helvetica Chemica Acta	24	69.9
			Biochemical Journal	22	73.8
			Biochemische Zeitschrift	21	77.5
			Nature	15	80.2
			U. S. Bureau of Standards. Journal of Research	14	82.6
			Académie des Sciences, Paris. Comptes Rendus	13	84.9
Vitamin chemistry	229	1,653	*Biochemical Journal*	229	13.8
			Journal of Biological Chemistry	137	22.1
			Nature	99	28.1
			Lancet	66	32.1
			Hoppe-Seyler's Zeitschrift für physiologische Chemie	66	36.1
			Journal of Nutrition	53	39.3
			Helvetica Chemica Acta	49	42.2
			Klinische Wochenschrift	48	45.1
			Biochemische Wochenschrift	43	47.7
			Deutsche chemische Gesellschaft. Bericht	42	50.2
Enzyme chemistry	47	723	*Hoppe-Seyler's Zeitschrift für physiologische Chemie*	207	28.6
			Biochemische Zeitschrift	161	50.9
			Biochemical Journal	97	64.3
			Journal of Biological Chemistry	59	72.5
			Die Naturwissenschaften	22	75.5
			Nature	22	78.5
			Journal of General Physiology	18	80.9
			Deutsche chemische Gesellschaft. Bericht	16	83.2
			Fermentforschung	14	85.1

TABLE 3—*Continued*

Subject	Total Number of Periodicals	Total Number of References	Leading Journals	Number of References	Cumulative % of References
Nutrition	127	613	*Journal of Nutrition*	99	16.2
			Journal of Biological Chemistry	70	27.6
			American Journal of Physiology	62	37.7
			Society for Experimental Biology and Medicine. Proceedings	29	42.4
			Science	21	45.3
			American Medical Association. Journal	18	48.8
			Journal of Agricultural Research	15	51.3
			American Journal of Diseases of Children	12	53.2
			Chinese Journal of Physiology	12	55.1
			Klinische Wochenschrift	12	57.0
			Société de Biologie, Paris. Comptes Rendus	12	58.9
Hormone chemistry	108	1,288	*Society for Experimental Biology and Medicine. Proceedings*	163	12.7
			American Journal of Physiology	135	23.1
			Société de Biologie, Paris. Comptes Rendus	75	28.9
			Journal of Biological Chemistry	68	34.2
			Archiv für experimentelle Pathologie und Pharmakologie	63	39.2
			Klinische Wochenschrift	61	43.9
			Journal of Physiology	60	48.6
			Endocrinology	57	53.1
			Journal of Pharmacology and Experimental Therapeutics	35	56.0
			Biochemical Journal	35	58.9

Stevens[17] how styles have changed in research interests in the field of botany. They change for other sciences as well. The editorial policies of journals also change. Hence, even though the leading journals for a given subject are reliably determined at the time the literature is analyzed, the evaluation should be looked upon as only tentatively useful. The great similarity of the lists compiled for the medical sciences by Jenkins,[11] Sherwood,[16] and Gregory[4] over a period of seven years suggests that for broad fields such lists may be valid for a least a decade or more.

One interesting fact shown conclusively by several studies is that the primary interest of scientific readers is in the current literature. Sherwood[16] reported that 55 per cent of the citations are to publications of the current five-year period and that 75 per cent are for the current ten-year period. Jenkins[11] reported that, "There were 7.1 times as many references to periodicals of the last decade as to those of the one preceding it," and pointed out the important bearing this has on the buying policy of the library. An analysis of 2479 citations tabulated from the *Journal of Biological Chemistry* and *Hoppe-Seyler's Zeitschrift für physi-*

*ologische Chemie** gave for biochemistry percentages similar to those of Sherwood, 46 per cent and 69 per cent, respectively, for the current five- and ten-year periods.†

An interesting characteristic of the periodical lists prepared by Jenkins,[11] Mengert,[15] Gregory[5, 6] and others who use the statistical approach, is that a very high percentage of the references is concentrated in a small percentage of the periodicals. Gregory[5] has shown this quite

TABLE 4

The interdependence of biochemistry and other sciences as shown by an analysis of the bibliographical citations in the *Annual Review of Biochemistry*, vol. I–IV (1932–1935). The subjects are arranged in the order of their importance for the literature of biochemistry

Subject	Number of Journal Titles	% of Total	Number of Citations	% of Total
Biochemistry	14	2.1	4,528	33.9
Medicine	233	34.8	2,365	17.7
Physiology*	38	5.7	2,086	15.6
Chemistry	42	6.2	1,513	11.2
Biology†	39	5.8	800	6.0
Science (General)	44	6.6	577	4.3
Botany‡	29	4.3	328	2.5
Agriculture	77	11.5	282	2.1
Technology	36	5.4	238	1.8
Publications of Learned Societies (General)	22	3.3	220	1.7
Bacteriology and Immunology	7	1.1	192	1.5
Zoology	31	4.6	102	0.8
Physics and Mathematics	7	1.1	31	0.2
Miscellaneous (including unclassified)	50	7.5	98	0.7
Totals	669	100.0	13,360	100.0

* Including nutrition and endocrinology.
† Including a few general natural history journals.
‡ Including plant physiology.

clearly by some interesting comparisons. In general medicine and in endocrinology, 25 per cent of the significant periodical literature is to be found in three of the most important journals of the respective fields. In general medicine and in endocrinology of sex, only 17 journals are needed to supply 50 per cent of the most important literature, and in general medicine (Sherwood list) the fifty leading journals contain 70 per cent of the more significant scientific papers. From Tables 2 and 3 it can be seen that the same concentration is found in biochemical litera-

* The *Annual Review of Biochemistry* did not reflect this situation, as all the references are to current publications.

† Where the bibliographies in periodicals reporting original investigations are used for analyses to evaluate periodicals, this interest in current literature effects the value of the study. If the total number of citations to each periodical title is used, instead of the number for the most recent period only, the resulting list of periodicals may be quite misleading in respect to the relative importance of periodicals published *currently*. Cf. Gross and Gross (6), Tables I and III.

ture. Twelve journals contain 50 per cent of the most important papers in the field as a whole; and an even greater concentration is apparent for some of the special subjects. For example, more than half of the literature of enzyme chemistry is found in two German journals, and seven journals supply 85 per cent. For the small library with limited funds this concentration is encouraging information.

Conversely, it is discouraging to all libraries to note the very large number of titles through which the remaining significant literature is scattered. In his first 1800 references, Jenkins[11] found 305 periodicals cited. Within the bibliographies of the *Journal of the American Medical Association* for one year Sherwood[16] found references to 556 periodicals. Cunningham[2] reports that there are 2221 current journals in the medical and biological sciences. This dispersion of the literature is particularly disheartening among some of the specialties. Mengert[15] found citations to 325 journals in his analysis of the literature on the endocrinology of sex; and in this study of the periodical literature of biochemistry it was found that the current periodical publications on the chemistry of vitamins are scattered through 218 or more scientific and technical journals. It is this situation which makes the *Annual Review of Biochemistry, Physiological Reviews,* and other such publications imperative.

One of the interesting results shown by several studies is that the specialized journal for a given field is not necessarily the most important. For example, Gregory[5] shows that for endocrinology, the two most important journals are the *American Journal of Physiology* and the *Comptes Rendus de la Société de Biologie,* with *Endocrinology* being ranked third. In the Mengert study of the endocrinology of sex, *Endocrinology* ranks eighth with the *American Journal of Physiology,* the *Comptes Rendus de la Société de Biologie,* the *Proceedings of the Society for Experimental Biology and Medicine, Anatomical Record, American Journal of Anatomy, Journal of Experimental Zoology, and Archiv für Gynäkologie* being ranked as more important, although the last two are about on a par with the specialized journal.

In the study of the periodical literature of biochemistry the same sort of situation was not found to be true, because of the existence of four well established journals in this field. But in spite of these four large specialized journals, and several others of less importance, a surprising proportion of the significant current literature is found in journals of general chemistry or in journals devoted primarily to other subjects.

The expression, "devoted primarily," is used carefully, for one of the important facts shown by these bibliographical studies is the extent to which the journal literature demonstrates the interrelationships of the sciences. It is indicated in the information about the journals most significant for endocrinology, and it is especially clear in the results of the analysis of the periodical literature of biochemistry. Data presented in

Table 4 demonstrates clearly the extent to which the biochemist must use the literature of many other subject fields, as well as the fact that biochemistry is of importance as a related subject to many kinds of specialists. The principal subject of each journal was determined by ascertaining the Library of Congress classification number in the library catalog at the University of Chicago, or in the depository catalog at that institution. In some cases, when titles appeared in neither of these catalogs, classification was otherwise determined.

The results of this and other such studies seem to make a definite contribution to the problem of selecting periodicals for the library; but also implicit in them is information of value in library administration. The objective data concerning the degrees of concentration and dispersion of the literature of particular subjects and the reflection in scientific literature of the interdependence of the sciences may prove especially useful in the determination of policies for the organization of subject departments and departmental libraries or for bringing together those already established.

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